SYMBOLIC CHEMISTRY.

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SYMBOLIC CHEMISTRY.

SYMBOLIC CHEMISTRY:

SHOWING THE

DECOMPOSITIONS

OF

INORGANIC SUBSTANCES;

WITH

TEST TABLES ANNEXED.

BY

EMILE CLEMENT,

LECTURER AND TEACHER OF NATURAL PHILOSOPHY AND CHEMISTRY

AT

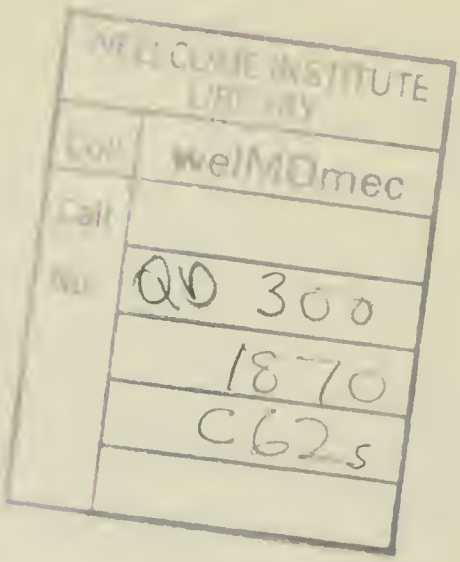
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PREFACE.

HAVING for many years found these Decomposition Tables of great utility in teaching Chemistry to my Pupils, I have been induced to lay them before the public, in the hope that they will be found useful to those who have to impart instruction in a branch of Education which is now becoming increasingly appreciated as a necessary part of the training of the young.

From my success in preparing Pupils in this subject for the Matriculation Examination of the University of London, as well as for the Oxford and Cambridge Local Examinations, I feel confident that this little work will be found of great use both to Masters and Pupils.

E. C.

BRAMHAM COLLEGE,

November, 1870.


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CLASSIFICATION OF ELEMENTS

ACCORDING TO THEIR

POWER OF EQUIVALENTS.

Mono-equivalents.		Di-equivalents.		Tri-equivalents.		Tetra-equivalents.	
K	39·1	Ba	137	As	75	Pt	197·4
Na	23	Sr	87·6	Sb	120	†Sn	118
Ag	108	Ca	40	Bi	210	Si	28
Au	197	Mg	24	Al	27·5	†C	12
H	1	*Fe	56	Cr	52·5		
Cl	35·5	Zn	65	*Fe	56		
Br	80	Mn	55	N	14		
I	127	Ni	59	P	31		
F	19	Co	59				
		†Sn	118				
		Cu	63·5				
		Hg	200				
		O	16				
		S	32				
		†C	12				
		Se	79				

* Fe in its combination is sometimes of Tri-equivalent power.

† C and Sn in its combination is sometimes of Tetra-equivalent power.

Symbolic Chemistry.

NON-METALLIC ELEMENTS.

Hydrogen. 1.

$K + H_2O = KHO + H.$

$Fe + H_2O = FeO + H_2.$

$Zn + H_2SO_4 = ZnSO_4 + H_2.$

$Zn + 2HCl = ZnCl_2 + H_2.$

Oxygen. 16.

$HgO + \text{heat} = Hg + O.$

$MnO_2 + H_2SO_4 = MnSO_4 + H_2O + O.$

$KClO_3 + \text{heat} = KCl + O_3.$

Chlorine. 35·5.

$MnO_2 + 4HCl = MnCl_2 + 2H_2O + 2Cl.$

$2NaCl + MnO_2 + 2H_2SO_4 = Na_2SO_4 + MnSO_4 + 2H_2O + Cl_2.$

$2NaCl + H_2SO_4 = Na_2SO_4 + 2HCl.$

$2HgO + 4Cl = Hg_2(Cl_2O) + Cl_2O.$

$2KClO_3 + H_2SO_4 = K_2SO_4 + H_2O + Cl_2O_5.$

$Cl_2O_5 + \text{heat} + KClO_3 = KClO_4 + Cl_2O_4.$

$6KHO + 6Cl = 3H_2O + 5KCl + KClO_3.$

Bromine. 80.

$Mg Br_2 + Mn O_2 + 2 H_2 S O_4 = Mg S O_4 + Mn S O_4 + 2 H_2 O + Br_2$.

$P Br_5 + 4 H_2 O = H_3 P O_4 + 5 H Br$.

$Br + 3 H_2 O + 5 Cl = 5 H Cl + H Br O_3$.

$2 Ag Br + 2 H N O_3 = 2 Ag N O_3 + 2 H Br$.

Iodine. 127.

$2 K I + Mn O_2 + 2 H_2 S O_4 = K_2 S O_4 + Mn S O_4 + 2 H_2 O + I_2$.

$Mg I_2 + Mn O_2 + 2 H_2 S O_4 = Mn S O_4 + Mg S O_4 + 2 H_2 O + I_2$.

$H_2 S + I_2 = S + 2 H I$.

$K I + H N O_3 = K N O_3 + H I$.

$Ag N O_3 + K I = Ag I + K N O_3$.

$Ag Cl + K I = K Cl + Ag I$.

Fluorine. 19.

$2 Ca F_2 + 2 H_2 S O_4 = 2 Ca S O_4 + 4 H F$.

$4 H F + Si O_2 = 2 H_2 O + Si F_4$.

$3 Si F_4 + 3 H_2 O = H_2 Si O_3 + H_4 Si_2 F_{12}$ or $2 (H_2 Si F_6)$.

Sulphur. 32.

$S + O_2 = S O_2$.

$2 H_2 S O_4 + Cu = Cu S O_4 + 2 H_2 O + S O_2$.

$Hg + 2 H_2 S O_4 = Hg S O_4 + 2 H_2 O + S O_2$.

$2 Fe S O_4 + H_2 O = 2 Fe O + H_2 S O_4, S O_3$.

$2 H N O_3 + 3 H_2 S O_3 = H_2 O + 3 H_2 S O_4 + N_2 O_2$.

$Fe S + H_2 S O_4 = H_2 S + Fe S O_4$.

Carbon. 12.

$Ca\,C\,O_3 + 2\,H\,Cl = H_2O + Ca\,Cl_2 + C\,O_2$.

$Ca\,C\,O_3 + H_2\,S\,O_4 = Ca\,S\,O_4 + H_2\,O + C\,O_2$.

$Fe + C\,O_2 = Fe\,O + C\,O$.

$H_2\,C_2\,O_4 + H_2\,S\,O_4 = H_2\,S\,O_4, H_2\,O + C_2\,O_3$.

$C_2\,O_3$ breaks up into $C\,O + C\,O_2$.

$C_2\,H_6\,O + H_2\,S\,O_4 = H_2\,O, H_2\,S\,O_4 + C_2\,H_4$.

$K\,C_2\,H_3\,O_2 + K\,H\,O = K_2\,C\,O_3 + C\,H_4$.

Silicon. 28.

$H_2\,Si\,O_3 + \text{heat} = H_2\,O + Si\,O_2$.

$2\,Ca\,F_2 + 2\,H_2\,S\,O_4 + Si\,O_2 = 2\,Ca\,S\,O_4 + Si\,F_4 + 2\,H_2\,O$.

$3\,Si\,F_4 + 3\,H_2\,O = H_2\,Si\,O_3 + 2\,(H_2\,Si\,F_6)$.

$Si\,S_2 + 2\,H_2\,O = 2\,H_2\,S + Si\,O_2$.

Nitrogen. 14.

Depriving air of its $O = N$.

$N\,H_3 + 3\,Cl = 3\,H\,Cl + N$.

$N\,H_4\,N\,O_3 + \text{heat} = 2\,H_2\,O + N_2\,O$.

$6\,H\,N\,O_3 + 3\,Cu = Cu_3\,(N\,O_3)_6 + 6\,H$.

$6\,H + 2\,H\,N\,O_3 = 4\,H_2\,O + N_2\,O_2$.

$Pb\,(N\,O_3)_2 + \text{heat} = Pb\,O + O + N_2\,O_4$.

$2\,K\,N\,O_3 + H_2\,S\,O_4 = K_2\,S\,O_4 + 2\,H\,N\,O_3$.

$K\,N\,O_3 + H_2\,S\,O_4 = K\,H\,S\,O_4 + H\,N\,O_3$.

$2AgNO_3 + 2Cl = 2AgCl + O + N_2O_5$.

$N_2\,O_5 + H_2\,O = 2\,H\,N\,O_3$.

$2\,H\,Cl + K\,N\,O_3 = H_2\,O + N_2\,O + Cl + K\,Cl$.

Phosphorus. 31.

$$\begin{cases} 3\,Ca\,O\,P_2\,O_5 + 2\,H_2\,S\,O_4 = 2\,(Ca\,S\,O_4) + Ca\,O\,2\,H_2\,O\,P_2\,O_5. \\ 3\,(Ca\,O\,2H_2O\,P_2O_5) + 10\,C = 10\,CO + 6\,H_2O + 3\,CaO,P_2O_5 + 4P. \end{cases}$$

$$\begin{cases} Ca_3\,(P\,O_4)_2 + 2\,H_2\,S\,O_4 = Ca\,H_4\,(P\,O_4)_2 + 2\,Ca\,S\,O_4. \\ Ca\,H_4\,(P\,O_4)_2 + \text{heat} = 2\,H_2\,O + Ca\,(P\,O_3)_2. \\ 3\,Ca\,(P\,O_3)_2 + 10\,C = 10\,C\,O + Ca_3\,(P\,O_4)_2 + 4\,P. \end{cases}$$

$$P\,I_3 + 3\,H_2\,O = H_3\,P\,O_3 + 3\,H\,I.$$

$$3\,K\,H\,O + 4\,P + 3\,H_2\,O = P\,H_3 + 3\,(K\,H_2\,P\,O_2.$$

$$4\,(H_3\,P\,O_3) + \text{heat} = P\,H_3 + 3\,(H_3\,P\,O_4).$$

Monobasic $= H_2\,O\,P_2\,O_5.$

Bibasic $= 2\,H_2\,O\,P_2\,O_5.$

Tribasic $= 3\,H_2\,O\,P_2\,O_5.$

Boron. 11.

$$B_2\,O_3 + 6\,Na = 3\,Na_2\,O + 2\,B.$$

$$(Na_2\,B_4\,O_7 + 10\,H_2\,O) + H_2\,S\,O_4 = Na_2\,S\,O_4 + B_4\,O_6 + 11\,H_2\,O.$$

$$B_4\,O_6 = 2\,(B_2\,O_3).$$

Selenium. 79.

$H_2\,Se\,O_4.$

$H_2\,Se\,O_3.$

$$K_2\,Se + H_2\,S\,O_4 = K_2\,S\,O_4 + H_2\,Se.$$

$$Fe\,Se + H_2\,S\,O_4 = Fe\,S\,O_4 + H_2\,Se.$$

METALLIC ELEMENTS.

FIRST CLASS ...K, Na, Li (NH_4).

SECOND CLASS...Ba, Sr, Co, Mg.

THIRD CLASS ...Al, Cr, Zn, Mn, Ni, Co, Fe.

FOURTH CLASS...Ag, Pb, Hg, Sb, Bi, Sn, Au, Pt, As, Cu, Cd.

POTASSIUM. 39·1.

$K_2O + C = CO + K_2$.

$K_2CO_3 + 2C = 3CO + K_2$.

$K_2CO_3 + CaH_2O_2 = CaCO_3 + 2KHO$.

$K + H_2O = KHO + H$.

$K_2SiO_3 + H_2CO_3 = K_2CO_3 + H_2O + SiO_2$.

$K_2CO_3 + Ca(NO_3)_2 = CaCO_3 + 2(KNO_3)$.

$K_2CO_3 + H_2SO_4 = K_2SO_4 + H_2O + CO_2$.

$2KNO_3 + 3C + S = K_2S + 3CO_2 + N_2$.

$FeI_2 + K_2CO_3 = 2KI + FeCO_3$.

$6KHO + 6Cl = 3H_2O + 5KCl + KClO_3$.

SODIUM. 23.

$Na_2CO_3 + 2C = 3CO + Na_2$.

$Na + H_2O = NaHO + H$.

$Na_2CO_3 + CaH_2O_2 = CaCO_3 + 2NaHO$.

$2\,NaCl + H_2SO_4 = Na_2SO_4 + 2\,HCl.$

$Na_2SO_4 + 4\,C = 4\,CO + Na_2S.$

$Na_2S + CaCO_3 = CaS + Na_2CO_3.$

$Na_2HPO_4 + NH_4Cl = NaCl + Na, NH_4, HPO_4.$

$NaCl + AgNO_3 = NaNO_3 + AgCl.$

$Na_2CO_3 + 2\,HCl = H_2O + CO_2 + 2\,NaCl.$

$Na_2CO_3 + 2\,HNO_3 = 2\,NaNO_3 + H_2O + CO_2.$

$2\,NaBr + MnO_2 + 2\,H_2SO_4 = MnSO_4 + 2\,H_2O + Br_2 + Na_2SO_4.$

Ammonium. 18.

$(NH_4)_2CO_3 + 2\,HCl = 2\,NH_4Cl + H_2O + CO_2.$

$(NH_4)_2S + 2\,HCl = 2\,NH_4Cl + H_2S.$

$MgCl_2, 2\,NH_4Cl.$

$NiCl_2, 2\,NH_4Cl.$

$PtCl_2, 2\,(NH_4Cl.$

$CoCl_2, (NH_4Cl)_2.$

$(NH_4)_2CO_3 + H_2SO_4 = (NH_4)_2SO_4 + H_2O + CO_2.$

$(NH_4)_2CO_3 + 2\,HNO_3 = 2\,NH_4NO_3 + H_2O + CO_2.$

$Ca(C_2H_4O_2)_2 + 2\,NH_4Cl = CaCl_2 + 2\,NH_4, C_2H_4O_2.$

$NH_4HS + HCl = NH_4Cl + H_2S.$

Barium. 137.

$BaO + H_2O = BaH_2O_2.$

$BaCO_3 + 2\,HCl = BaCl_2 + H_2O + CO_2.$

$BaCO_3 + H_2SO_4 = BaSO_4 + H_2O + CO_2.$

$BaCO_3 + 2\,HNO_3 = Ba(NO_3)_2 + H_2O + CO_2.$

$Ba S O_4 + 4 C = 4 C O + Ba S.$

$Ba S + Ca C O_3 = Ba C O_3 + Ca S.$

$Ba S + 2 H Cl = H_2 S + Ba Cl_2.$

$Ba Cl_2 + 2 H N O_3 = Ba (N O_3)_2 + 2 H Cl.$

$Ba Cl_2 + 2 Ag N O_3 = Ba (N O_3)_2 + 2 Ag Cl.$

$Ba Cl_2 + Na_2 C O_3 = Ba C O_3 + 2 Na Cl.$

$Ba Cl_2 + H_2 S O_4 = Ba S O_4 + 2 H Cl.$

Strontium. 87·6.

$Sr O + H_2 O = Sr H_2 O_2.$

$Sr C O_3 + H_2 S O_4 = Sr S O_4 + H_2 O + C O_2.$

$Sr C O_3 + 2 H Cl = Sr Cl_2 + H_2 O + C O_2.$

$Sr C O_3 + 2 H N O_3 = Sr (N O_3)_2 + H_2 C O_3.$

$Sr Cl_2 + Na_2 C O_3 = Sr C O_3 + 2 Na Cl.$

$Sr S + 2 H Cl = H_2 S + Sr Cl_2.$

$Sr Cl_2 + 2 Ag N O_3 = Sr (N O_3)_2 + 2 Ag Cl.$

$Sr Cl_2 + (N H_4)_2 C_2 O_4 = Sr C_2 O_4 + 2 N H_4 Cl.$

Calcium. 40.

$Ca O + H_2 O = Ca H_2 O_2.$

$Ca C O_3 + 2 H Cl = Ca Cl_2 + H_2 O + C O_2.$

$Ca C O_3 + H_2 S O_4 = Ca S O_4 + H_2 C O_3.$

$Ca C O_3 + 2 H N O_3 = Ca (N O_3)_2 + H_2 O + C O_2.$

$Ca S + 2 H Cl = Ca Cl_2 + H_2 S.$

$Ca F_2 + H_2 S O_4 = Ca S O_4 + 2 H F.$

$Ca\,H_2\,O_2 + C\,O_2 = Ca\,C\,O_3 + H_2\,O.$

$Ca\,H_2\,O_2 + H_2\,S\,O_4 = Ca\,S\,O_4 + 2\,H_2\,O.$

$Ca\,Cl_2 + (N\,H_4)_2\,C_2\,O_4 = Ca\,C_2\,O_4 + 2\,N\,H_4\,Cl.$

$H_6\,P_2\,O_8 = 2\,(H_3\,P\,O_4).$

$Ca\,H_4\,(P\,O_4)_2$ = Mono-Calcic Phosphate.

$Ca_2\,H_2\,(P\,O_4)_2$ = Bi-Calcic Phosphate.

$Ca_3\,(P\,O_4)_2$ = Tri-Calcic Phosphate.

$$\begin{cases} (Ca\,Cl_2O_2 + Ca\,Cl_2) + 2\,H_2SO_4 = 2\,H\,Cl + 2\,Ca\,S\,O_4 + Cl_2O + H_2O. \\ Cl_2\,O + 2\,H\,Cl = H^2\,O + 4\,Cl. \end{cases}$$

Magnesium. 24.

$Mg\,O + H_2\,O = Mg\,H_2\,O_2.$

$Mg\,C\,O_3 + H_2\,S\,O_4 = Mg\,S\,O_4 + H_2\,O + C\,O_2.$

$Mg\,C\,O_3 + 2\,H\,Cl = Mg\,Cl_2 + H_2\,O + C\,O_2.$

$Mg\,O + 2\,H\,Cl = Mg\,Cl_2 + H_2\,O.$

$2\,Mg\,S\,O_4 + 2\,Na_2\,H\,(P\,O_4)_2 = Mg_2\,H_2\,(P\,O_4)_2 + 2\,Na_2\,S\,O_4.$

$Mg\,S\,O_4 + K_2\,C\,O_3 = Mg\,C\,O_3 + K_2\,S\,O_4.$

Zinc. 65.

$Zn\,C\,O_3 + 2\,C = Zn + 3\,C\,O.$

$Zn\,Cl_2 + K_2\,C\,O_3 = Zn\,C\,O_3 + 2\,K\,Cl.$

$Zn + H_2\,S\,O_4 = Zn\,S\,O_4 + H_2.$

$Zn + 2\,H\,Cl = Zn\,Cl_2 + H_2.$

$Zn\,S + H_2\,S\,O_4 = Zn\,S\,O_4 + H_2\,S.$

$Zn\,S\,O_4 + 2\,K\,H\,O = Zn\,H_2\,O_2 + K_2\,S\,O_4.$

$Zn\,Cl_2 + (N\,H_4)_2\,C\,O_3 = Zn\,C\,O_3 + 2\,N\,H_4\,Cl.$

Iron. 56.

$Fe\,O$. $Fe_2\,O_3$. $(Fe\,O + Fe\,O_3)$. $Fe\,O_3$. $Fe\,Cl_2$. $Fe_2\,Cl_6$.
$Fe\,I_2$. $Fe\,S$. $Fe\,2\,N\,O_3$. $Fe_2\,6\,N\,O_3$.

$Fe\,C\,O_3 + H_2\,S\,O_4 = Fe\,S\,O_4 + H_2\,O + C\,O_2$.

$Fe + H_2\,S\,O_4 = Fe\,S\,O_4 + H_2$.

$Fe + 2\,H\,Cl = Fe\,Cl_2 + H_2$.

$Fe_2\,O_3 + 6\,H\,Cl = Fe_2\,Cl_6 + 3\,H_2\,O$.

$Fe\,S\,O_4 + 2\,K\,H\,O = Fe\,H_2\,O_2 + K_2\,S\,O_4$.

$2\,(Fe_2\,O_3\,3\,S\,O_4) + 3\,K_4\,Fcy = Fe_4\,Fcy_3 + 6\,K_2\,S\,O_4$.

$2\,K_4\,Fe\,Cy_6 + Cl_2 = 2\,K_3\,Fe\,Cy_6 + 2\,K\,Cl$.

Manganese. 55.

$Mn\,S\,O_4 + 2\,K\,H\,O = Mn\,H_2\,O_2 + K_2\,S\,O_4$.

$Mn\,Cl_2 + 2\,K\,H\,O = 2\,K\,Cl + Mn\,H_2\,O_2$.

$2\,Na\,H\,O + Mn\,S\,O_4 = Na_2\,S\,O_4 + Mn\,H_2\,O_2$.

$Mn\,O_2 + 4\,H\,Cl = Mn\,Cl_2 + 2\,H_2\,O + Cl_2$.

$Mn\,Cl_2 + K_2\,C\,O_3 = Mn\,C\,O_3 + 2\,K\,Cl$.

$Mn\,O + H_2\,S\,O_4 = Mn\,S\,O_4 + H_2\,O$.

$2\,Mn\,O_2 + \text{heat} = Mn_2\,O_3 + O$.

Nickel. 59.

$Ni\,Cl_2 + 2\,K\,H\,O = Ni\,H_2\,O_2 + 2\,K\,Cl$.

$Na_2\,C\,O_3 + Ni\,Cl_2 = Ni\,C\,O_3 + 2\,Na\,Cl$.

$Ni\,C\,O_3 + H_2\,S\,O_4 = Ni\,S\,O_4 + C\,O_2 + H_2\,O$.

Cobalt. 59.

$Co\,Cl_2 + 2\,Na\,H\,O = Co\,H_2\,O_2 + 2\,Na\,Cl.$

$Na_2\,C\,O_3 + Co\,Cl_2 = Co\,C\,O_3 + 2\,Na\,Cl.$

$Co\,H_2\,O_2 + 2\,H\,N\,O_3 = Co\,(N\,O_3)_2 + 2\,H_2\,O.$

$Co\,H_2\,O_2 + H_2\,S\,O_4 = Co\,S\,O_4 + 2\,H_2\,O.$

$Co\,Cl_2 + Na_2\,C\,O_3 = Co\,C\,O_3 + 2\,Na\,Cl.$

Aluminium. 27·5.

$Al_2\,Cl_6 + 6\,Na = 6\,Na\,Cl + 2\,Al.$

$Al_2\,(Si\,O_3)_3 + 3\,H_2\,S\,O_4 = Al_2\,(S\,O_4)_3 + 3\,H_2\,O + 3\,Si\,O_2.$

$Fe\,S_2 + H_2\,O + 7\,O$ (from air) $= Fe\,S\,O_4 + H_2\,S\,O_4.$

$3\,H_2\,S\,O_4 + Al_2\,(Si\,O_3)_3 = Al_2\,(S\,O_4)_3 + 3\,H_2\,O + Si\,O_2.$

$Fe\,S\,O_4 + 2\,K\,Cl = Fe\,Cl_2 + K_2\,S\,O_4.$

$Al_2\,(S\,O_4)_3 + K_2\,S\,O_4 + 24\,H_2\,O.$

Chromium. 52·5.

$Cr\,O + C = C\,O + Cr.$

$Fe\,O + Cr_2\,O_3 =$ Crome iron ore.

$Cr\,Cl_2 + 2\,K\,H\,O = 2\,K\,Cl + (H_2\,O + Cr\,O)$ or $Cr\,H_2\,O_2.$

$Cr\,Cl_2 + N\,H_4\,O = N\,H_4\,Cl_2 + Cr\,O.$

$K_2\,Cr\,O_4, Cr\,O_3 + H_2\,S\,O_4 = K_2\,S\,O_4 + H_2\,O + 2\,Cr\,O_3.$

$2\,Cr\,O_3 + 3\,H_2\,S\,O_4 = Cr_2\,(S\,O_4)_3 + 3\,H_2\,O + 3\,O.$

$Pb\,(N\,O_3)_2 + K_2\,Cr\,O_4 = Pb\,Cr\,O_4 + 2\,K\,N\,O_3.$

$K_2\,Cr\,O_4 + 2\,Ag\,N\,O_3 = Ag_2\,Cr\,O_4 + 2\,K\,N\,O_3.$

$Fe\,O + Cr_2\,O_3 + 4\,K\,N\,O_3 = 2\,K_2\,Cr\,O_4 + 4\,N\,O_2 + Fe.$

$H_2\,S\,O_4 + 2\,K_2\,Cr\,O_4 = K_2\,S\,O_4 + 2\,(K\,H\,Cr\,O_4).$

$2\,(K\,H\,Cr\,O_4) +$ heat $= K_2\,Cr\,O_4, Cr\,O_3 + H_2\,O.$

Cadmium. 112.

$Cd\,C\,O_3 + \text{heat} = Cd\,O + C\,O_2.$

$Cd\,O + H_2\,S\,O_4 = Cd\,S\,O_4 + H_2\,O.$

$Cd\,Cl_2 + H_2\,S = Cd\,S + 2\,H\,Cl.$

$Cd\,Cl_2 + 2\,K\,H\,O = Cd\,H_2\,O_2 + 2\,K\,Cl.$

Silver. 108.

$2\,Ag\,N\,O_3 + 2\,K\,H\,O = Ag_2\,O + 2\,K\,N\,O_3 + H_2\,O.$

$3\,Ag + 4\,H\,N\,O_3 = 3\,(Ag\,N\,O_3) + 2\,H_2\,O + N\,O.$

$2\,Ag\,Cl + Ba\,(N\,O_3)_2 = 2\,Ag\,N\,O_3 + Ba\,Cl_2.$

$K\,I + Ag\,N\,O_3 = Ag\,I + K\,N\,O_3.$

$2\,Ag\,N\,O_3 + K_2\,S\,O_4 = 2\,K\,N\,O_3 + Ag_2\,S\,O_4.$

$K\,Br + Ag\,N\,O_3 = K\,N\,O_3 + Ag\,Br.$

$Ba\,Cl_2 + 2\,Ag\,N\,O_3 = Ba\,(N\,O_3)_2 + 2\,Ag\,Cl.$

$2\,Ag\,N\,O_3 + H_2\,S = Ag_2\,S + 2\,H\,N\,O_3.$

$2\,Ag\,N\,O_3 + Na_2\,C\,O_3 = Ag_2\,C\,O_3 + 2\,Na\,N\,O_3.$

$Na\,Cl + Ag\,N\,O_3 = Ag\,Cl + Na\,N\,O_3.$

$Ag\,Cl + Na\,C\,O_3 = Na\,Cl + Ag + C\,O_2 + O.$

Lead. 208.

$Pb\,S$ = Galena.

$Pb\,S + Pb\,S + \text{heat and air} = Pb\,S\,O_4 + Pb\,S.$

$Pb\,S\,O_4 + Pb\,S + \text{heat} = 2\,S\,O_2 + 2\,Pb.$

$Pb\,C\,O_3 + \text{heat} = Pb\,O + C\,O_2$ ($Pb\,O$ = Massicot, Litharge).

$3\,Pb\,O + \text{heat and air} = 2\,Pb\,O + Pb\,O_2$ ($Pb_3\,O_4$ Red oxide, Red Lead).

$Pb\,C\,O_3 + 2\,N\,H\,O_3 = Pb\,(N\,O_3)_2 + H_2\,O + C\,O_2.$

$Pb\,(C_2\,H_3\,O_2)_2 + Na_2\,C\,O_3 = Pb\,C\,O_3 + 2\,Na\,C_2\,H_3\,O_2.$

$Pb\,(C_2\,H_3\,O_2)_2 + 2\,Na\,Cl = Pb\,Cl_2 + 2\,Na\,C_2\,H_3\,O_2.$

$2\,K\,I + Pb\,(C_2\,H_3\,O_2)_2 = 2\,K\,C_2\,H_3\,O_2 + Pb\,I_2.$

$Pb\,Cl_2 + 2\,K\,I = 2\,K\,Cl + Pb\,I_2.$

$K_2\,Cr\,O_4 + Pb\,Cl_2 = Pb\,Cr\,O_4 + 2\,K\,Cl.$

$Pb\,Cl_2 + H_2\,S = Pb\,S + 2\,H\,Cl.$

$Pb\,(C_2\,H_3\,O_2)_2 + H_2\,S = Pb\,S + H_2\,O + C_2\,H_3\,O.$

$Pb\,Cl_2 + H_2\,S\,O_4 = Pb\,S\,O_4 + 2\,H\,Cl.$

$K_2\,Cr\,O_4 + Pb\,(C_2\,H_3\,O_2)_2 = 2\,K\,C_2\,H_3\,O_2 + Pb\,Cr\,O_4.$

Copper. 63·5.

$Cu\,H_2\,O_2 + Cu\,C\,O_3 =$ Malachite.

$Cu\,S\,O_4 + 2\,K\,H\,O = Cu\,H_2\,O_2 + K_2\,S\,O_4.$

$Na_2\,C\,O_3 + Cu\,S\,O_4 = Na_2\,S\,O_4 + Cu\,C\,O_3.$

$3\,Cu + 6\,H\,N\,O_3 = 3\,Cu\,(N\,O_3)_2 + 6\,H.$

$6\,H + 2\,H\,N\,O_3 = 4\,H_2\,O + N_2\,O_2$ or $2\,N\,O.$

$Cu\,O + 2\,H\,Cl = Cu\,Cl_2 + H_2\,O.$

$Cu\,S\,O_4 + H_2\,S = Cu\,S + H_2\,S\,O_4.$

$Cu\,(N\,O_3)_2 + H_2\,S = Cu\,S + 2\,H\,N\,O_3.$

$Cu\,Cl_2 + H_2\,S = Cu\,S + 2\,H\,Cl.$

$Cu\,S\,O_4 + Fe = Fe\,S\,O_4 + Cu.$

Brass is an alloy of 70 parts of Cu and 30 parts of Zn.

Gun Metal „ 20 „ Cu „ 10 „ Sn.

Bronze „ 91 Cu, 2 Sn, 6 Zn, and 1 Pb.

Mercury. 200.

$2\,HgCl + 2\,KHO = Hg_2O + 2\,KCl + H_2O.$

$HgS + CaO = Hg + CaS + O.$

$2\,HgNO_3 + 2\,KHO = 2\,KNO_3 + H_2O + Hg_2O.$

$HgSO_4 + 2\,NaCl = HgCl_2 + Na_2SO_4.$

$HgCl + KI = HgI + KCl.$

$2\,HgCl + Na_2CO_3 + \text{heat} = 2\,NaCl + CO_2 + O + Hg_2.$

$2\,HgNO_3 + H_2S = Hg_2S + 2\,HNO_3.$

$Hg_2Cl_2 + 2\,KHO = 2\,KCl + Hg_2H_2O_2.$

$Hg(NO_3)_2 + Cu = Cu(NO_3)_2 + Hg.$

$Hg_2(NO_3)_2 + 2\,NaCl = Na_2(NO_3)_2 + Hg_2Cl_2.$

Antimony. 120.

$Sb_2S_3 + 3\,Fe + \text{heat} = Sb_2 + 3\,FeS.$

$2\,Sb + \text{heat and air} = Sb_2O_3.$

Sb_2O_3 oxide of Antimony.

Sb_2O_4 Antimonious Acid.

Sb_2O_5 Antimonic Acid.

$Sb_2O_3 + 2\,KHC_4H_4O_6 = 2\,SbKC_4H_4O_8 + H_2O.$

$Sb_2S_3 + 6\,HCl = 2\,SbCl_3 + 3\,H_2S.$

Bismuth. 210.

$\left\{\begin{array}{l} Bi + 6\,HNO_3 = Bi(NO_3)_2 + 6\,H. \\ 6\,H + 2\,HNO_3 = 4\,H_2O + 2\,NO. \end{array}\right.$

$3\,BiCl_3 + 4\,H_2O = Bi_3O_2Cl_3\,2\,H_2O + 6\,HCl.$

$BiCl_3 + 3\,KHO = BiH_3O_3 + 3\,KCl.$

$2\,BiCl_3 + 3\,K_2CO_3 = 6\,KCl + 2\,BiCO_3 + CO_2 + O.$

$2\,BiCl_3 + 3\,H_2S = Bi_2S_3 + 6\,HCl.$

Tin. 118.

$Sn O_2$ = Tinstone.

$K_2 C O_3 + Sn Cl_2 + H_2 O = 2 K Cl + C O_2 + Sn H_2 O_2$.

$Sn + 2 H Cl = Sn Cl_2 + 2 H$.

$Sn Cl_2 + 2 K H O = Sn H_2 O_2 + 2 K Cl$.

$Sn Cl_4 + 4 K H O = H_2 Sn O_3 + H_2 O + 4 K Cl$.

$2 Au Cl_3 + 3 Sn Cl_2 + 6 H_2 O = Au_2 Sn O_3 Sn Sn O_3 + 12 H Cl$.

$Sn Cl_2 + H_2 S = Sn S + 2 H Cl$.

Arsenic. 75.

$2 As$ + heat and air = $As_2 O_3$ (arsenious anhydride).

$As_2 O_5$ = arsenic anhydride

$As_2 O_5 + 3 H_2 O = H_6 As_2 O_8 = 2 (H_3 As O_4)$.

$As_2 S_2$ = Realgar.

$As_2 S_3$ = Orpiment.

$As_2 O_3 + 3 H_2 S = As_2 S_3 + 3 H_2 O$.

$As_2 S_3 + 3 K_2 S = As_2 K_6 S_6 = 2 (K_3 As S_3)$.

$K_3 As S_3 + 3 H Cl = H_3 As S_3 + 3 K Cl$.

$2 (H_3 As S_3) = 3 H_2 S + As_2 S_3$.

$Cu H As O_3$ = Scheele's Green.

$As_2 O_3 + 6 Zn + 6 H_2 S O_4 = 6 Zn S O_4 + 12 H$.

$12 H + As_2 O_3 = 3 H_2 O + 2 As H_3$.

TEST TABLES

FOR

SUBSTANCES IN SOLUTION.

First Class.

METALS OF THE ALKALIES.

H Cl and H_2S no precipitate.

NH_4HS . . no precipitate.

Na_2HPO_4 . no precipitate.

SPECIAL CHARACTERS.

Metallic Oxides.	Bichloride of Platinum.	Tartaric Acid.	
Potash .	Yellow prec.	White prec.	Alcohol and blow-pipe flame, Mauve colour.
Soda . .	No ,,	No ,,	Alcohol and blow-pipe flame, Yellow.
Ammonia	Yellow ,,	White ,,	Lime or Potash added to compounds of Ammonia on application of heat, gaseous Ammonia is evolved.

Second Class.

METALS OF THE ALKALINE EARTHS.

H Cl and H_2S no precipitate.

NH_4HS . . no precipitate.

Na_2HPO_4 . white precipitate.

SPECIAL CHARACTERS.

Metallic Oxides.	Sulphate of Lime.	
Baryta .	White prec.	Hyposulphite of Soda, white prec.
Strontia .	White ,,	,, ,, no ,,
Lime . .	No ,,	Oxalate of Ammonia, white ,,
Magnesia	No ,,	,, ,, no ,,

Third Class.

METALS OF THE EARTHS PROPER.

H Cl. and H_2S no precipitate.

NH_4HS . . a precipitate.

SPECIAL CHARACTERS.

Metallic Oxides.	Sulphide of Ammonium.	Ammonia.
Alumina . . .	White . . .	White, ins. in excess.
Chromium . .	Blue-green . .	Blue-green.
Zinc	White . . .	White, sol. in excess.
Manganese . .	Skin-coloured .	Skin-coloured.
Nickel . . .	Black } insoluble	Light green.
Cobalt . . .	Black } in H Cl	Blue.
Iron (Protoxide)	Black } soluble	Green.
Iron (Peroxide)	Black } in H Cl	Red-brown.

Fourth Class.

METALS PROPER.

H Cl and H_2S, a precipitate

If on the addition of H Cl a precipitate falls.

Oxides of Metals.	Hydrochloric Acid.	Ammonia.	
Silver . .	White, curdy	Soluble .	K H O, brown prec.
Lead . .	White . .	Blackened	K I, yellow prec.
Mercury .	White . .	Insoluble.	K I, scarlet prec. sol. in excess.

If on the addition of H Cl no precipitate falls, add H_2S.

Oxides of Metals.	Hydrosulphuric Acid.		Ammonia.
Copper . . .	Black . . .		Green-blue, sol. in excess, to azure blue, sol.
Gold	Black . . .		Red-yellow.
Platinum . .	Black . . .		Yellow.
Antimony (ter)	Orange-red .		White, ins. in excess.
Tin (pro) . .	Brown . . .		White, ins. in excess.
Tin (bin) . .	Yellow, insol. in Ammonia		White, slightly sol. in excess; K H O white, sol. in excess.
Arsenious Acid	Yellow	Soluble in Ammonia.	No prec.; Ammonio Nit. of Silver, yellow.
Arsenic Acid .	Yellow	Soluble in Ammonia.	No prec.; Ammonio-Nit. of Silver, red-brown.

TESTS FOR ACIDS.

First Class.

$Ba(NO_3)_2$ a precipitate.

SPECIAL CHARACTERS.

Acids.	Nitrate or Chloride of Barium.	
Sulphuric .	White, insol. in H Cl . .	
Carbonic .	White, sol. in HCl with efferves-cence.	
Silicic . .	White, sol. in HCl with separation of SiO_2 in gela-tinous form.	
Chromic .	Yellow prec. .	Nitrate of Silver, purple-red.
Phosphoric	White, sol. in HCl	Nitrate of Silver, yellow.
Boracic .	White, ,, .	Add H_2SO_4 and Alcohol, heat in capsule gives a green flame.
Oxalic . .	White, ,, .	Chloride of Calcium, white prec. sol. in Nitric Acid.

Second Class.

$Ba(NO_3)_2$ no precipitate.

$AgNO_3$ a precipitate.

SPECIAL CHARACTERS.

Acids.	Nitrate of Silver.	
Hydrocyanic .	White, sol. in NH_4O	Add H_2SO_4 and heat, odour of Prussic Acid.
Hydrochloric .	White, sol. in NH_4O	Add $H_2SO_4 + MnO_2$ odour of Cl.
Hydriodic . .	Yellow	$HgCl_2$, scarlet prec.
Hydrobromic .	Yellowish-white.	
Hydrosulphuric	Black.	

Third Class.

$Ba(NO_3)_2$ no precipitate.

$AgNO_3$ no precipitate.

SPECIAL CHARACTERS.

Nitric Acid	Add $Cu + H_2SO_4$ orange-red fumes of N_2O_4.
,, ,,	$FeSO_4 + H_2SO_4$ dark brown layers.
Chloric Acid	Add $Cu + H_2SO_4$ no orange fumes.
,, ,,	$FeSO_4 + H_2SO_4$ no dark brown layers.

TESTS FOR UNKNOWN METALLIC SUBSTANCES WITH THE BLOWPIPE.

I.—Place a small fragment of the substance on charcoal, and heat it with the blowpipe. If the substance forms a white incandescent mass, moisten with $Co(NO_3)_2$ and heat again. It will be—

Zn, if the mass becomes green.
Al, ,, ,, ,, sky-blue.
Mn, ,, ,, ,, pink.

II.—Place the substance on charcoal, and heat in the inner blowpipe flame. (In some cases it is advisable to mix a little Na_2CO_3 with it.)

Ag or Sn if white, malleable metallic bead, without incrustation.
Pb ,, ,, ,, yellow ,,
Bi if white, brittle metallic bead ... yellow ,,
Sb ,, ,, ,, ... white ,,
Cu if red, malleable ,, ... no ,,
Zn if yellow incrustation becoming white on cooling.

III.—Add, by degrees, the substance to a bead of Borax, and heat in the inner and outer flame of the blowpipe.

	Outer Flame.	Inner Flame.
Cr ...	yellowish brown ...	emerald green.
Ni ...	brownish ...	gray.
Cu ...	light blue ...	colourless.
Co ...	dark blue ...	dark blue.
Fe ...	Br. yellow ...	bottle green.
Mn ...	purple ...	colourless.
Au ...	rosy red bead by reflected light, and blue bead by transmitted light.	

The following metallic oxides will colour the Borax bead grey and opaque :—

Ag, Zn, Cd, Pb, Bi, Sb.

IV.—Place the substance on the hook of a clean platinum wire, and heat in the inner blowpipe flame. (It is advisable to moisten with H Cl.)

K,	if outer flame		mauve coloured.
Na,	,,	,,	yellow.
Ba,	,,	,,	greenish yellow.
Sr,	,,	,,	crimson.
Ca,	,,	,,	orange-yellow.

To distinguish between Ag and Sn, heat the metallic bead in the outer blowpipe flame ; if it becomes tarnished, it is Sn (due to oxidation). Ag will remain bright or untarnished.

TO DETECT BY DRY TESTING.

NH_4, Hg, As, HNO_3, HI, HCl, HBr, HF, $S\ HClO_3$.

I.—Mix a small quantity of the substance with powdered charcoal and dry Na_2CO_3, and heat in test tube, to detect—

NH_4 by the odour and alkaline vapour.

Hg by the gray metallic globules of Hg, visible on the upper, cooler part of the test tube.

As by the black shining crust of As on the upper part of the test tube.

II.—Heat the substance with dry K_2SO_4 in a test tube to detect—

HNO_3 by brown acid vapours.

I (HI) by violet vapours.

Cl (HCl) by greenish yellow, bleaching vapours.

F (HF) by colourless, pungent vapours, etching glass.

Br (HBr) by brown fumes or vapours.

If the substance is heated on charcoal, and deflagration occurs, it is most likely a Nitrate or Chlorate. Test for it by II: if no brown acid vapours appear it must be a Chlorate.

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